# 9. Nutrient credits

CHAPTER 9



Animal manures and leguminous crops contain nutrients. When animal manures are applied to a field, nitrogen, phosphorus, and/or potassium fertilizer application rates should be reduced. When legumes, including green manures, are part of a crop rotation, nitrogen fertilizer (or manure) application rates should be reduced. Reducing fertilizer application rates to account for the nutrients supplied by manures and legumes is economically profitable, improves fertilizer use efficiency, and enhances water quality.

## Manure

Nutrient credits from a manure application should be taken the first crop year after the application. Because the nutrients in manure are not 100% available the first year after application, nutrient credits may also be taken for the second and third years after application for nitrogen (N) and sulfur (S). Estimated nutrient availabilities are given in Table 9.1.

First-year N availability varies with animal species and depends upon whether or not the manure is incorporated and how much time has elapsed between application and incor-

**Table 9.1.** Estimated nutrient availability for various manures.

| | N | | | $P_2O_5$ | $K_2O$ | S |
|---|---|---|---|---|---|---|
| | Time to incorporation | | | | | |
| | > 72 hours or not incorporated | 1 to 72 hours | < 1 hour or injected | | | |
| **First-year availability** | % of total | | | | | |
| Beef: liquid (≤ 11.0% DM)[a] | 30 | 40 | 50 | 80 | 80 | 55 |
| Beef: solid (> 11.0% DM) | 25 | 30 | 35 | 80 | 80 | 55 |
| Dairy: liquid (≤ 11.0% DM)[a] | 30 | 40 | 50 | 80 | 80 | 55 |
| Dairy: solid (> 11.0% DM) | 25 | 30 | 35 | 80 | 80 | 55 |
| Goat | 25 | 30 | 35 | 80 | 80 | 55 |
| Horse | 25 | 30 | 35 | 80 | 80 | 55 |
| Poultry (chicken, duck, and turkey) | 50 | 55 | 60 | 80 | 80 | 55 |
| Sheep | 25 | 30 | 35 | 80 | 80 | 55 |
| Swine | 40 | 50 | 65 | 80 | 80 | 55 |
| Veal calf | 30 | 40 | 50 | 80 | 80 | 55 |
| **Second-year availability** | % of total | | | | | |
| All species | 10 | 10 | 10 | 0 | 0 | 10 |
| **Third-year availability** | % of total | | | | | |
| All species | 5 | 5 | 5 | 0 | 0 | 5 |

[a] If dry matter (DM) is < 2.0% and $NH_4$-N is > 75% of total N, the following equation for first-year N availability may be used in an effort to better account for the high concentration of $NH_4$-N that may be found in these manures: first-year available N = $NH_4$-N + [0.25 x (Total N – $NH_4$-N)], assuming manure is injected or incorporated in < 1 hour.

poration (Table 9.1). This is because nitrogen in manure is in both inorganic (immediately available) and organic (not immediately available) forms. Nearly all the inorganic form is present as ammonium. Ammonium is easily volatilized to ammonia and lost if manure lays on the soil surface. After 1 hour, a large portion of the ammonium is assumed to have volatilized unless significant rainfall has occurred. This volatilization loss may continue at a lower rate for several more days unless the manure is incorporated. For this reason, the N credits for surface-applied, unincorporated manure are less than when manure is incorporated or injected. Organic N availability is dependent upon animal species and management plus environmental factors such as moisture and temperature that affect microbial decomposition.

Phosphorus (P) in manures is present in both inorganic and organic forms. For most animal species, the inorganic P forms are dominant. Wisconsin research has demonstrated that first-year availability of manure P is equivalent to the availability of commercial fertilizer applied at the same rate of total $P_2O_5$. Potassium (K) in manures is in the inorganic form and is readily available to plants. Because there is some inherent variability in spreading manure evenly across the field and also variability with the nutrient content of each load of manure, the first-year availability of P and K is 80%. No second- or third-year credit is given for manure P or K. Any manure P or K applied, but not credited in the first year, is best accounted for by subsequent soil testing.

Manure sulfur (S) is in both inorganic and organic forms. First-year availability of manure S is estimated at 55%.

Manure nutrients are available to crops the second and third years after application. For all nutrients other than P and K, second- and third-year availabilities are estimated at 10% and 5%, respectively, of the total amount applied in the first year. The sum of the first-, second-, and third-year availabilities for a nutrient does not equal 100%. This is because some losses will occur, particularly with N, and because manure applications are not always uniform in rate and composition across a field. These estimates of nutrient availability are agronomically conservative to ensure that adequate nutrients are available for the crop.

To calculate the nutrient credits from manure, it is necessary to know the application rate and total nutrient content of the manure. Total nutrient content can be measured on a manure sample sent to most soil testing laboratories. For details on how to sample manure for testing, see UW-Extension publication *Recommended Methods of Manure Analysis* (A 3769). Where specific nutrient analysis for a manure is unknown, typical nutrient contents (also called book values) based on animal species and management can be used. Typical nutrient contents of Wisconsin manures are provided in Table 9.2. Because manure nutrient content can vary greatly from farm to farm, and book values represent an average nutrient content, it is preferable to occasionally have all manure types on a farm analyzed. Once manure application rate and total nutrient content are known, nutrient credits can be calculated as follows.

**First-year credits** = total nutrient content x % of nutrient that is available the 1st year after application x application rate

**Second-year credits** = total nutrient content x % of nutrient that is available the 2nd year after application x application rate

**Third-year credits** = total nutrient content x % of nutrient that is available the 3rd year after application x application rate

If manure is applied in multiple years, the credits are additive. In other words, take credits for current year nutrients plus any nutrient credits from the previous 2 years.

**Table 9.2.** Typical total nutrient content of manures tested in Wisconsin (1998–2012).

| | Dry Matter (DM) | N | $P_2O_5$ | $K_2O$ | S |
|---|---|---|---|---|---|
| **Solid manure** | % | lb/ton | | | |
| Beef | 29 | 13 | 8 | 12 | 1.9 |
| Dairy: semi-solid (11.1–20.0% DM) | 15 | 8 | 4 | 6 | 0.8 |
| Dairy: solid (> 20.0% DM) | 33 | 9 | 4 | 7 | 1.2 |
| Goat | 43 | 13 | 7 | 10 | 2.0 |
| Horse | 33 | 10 | 6 | 8 | 1.3 |
| Poultry: chicken | 57 | 49 | 44 | 33 | 3.0 |
| Poultry: duck | 36 | 12 | 10 | 9 | 1.8 |
| Poultry: turkey | 59 | 51 | 44 | 31 | 3.8 |
| Sheep | 34 | 19 | 9 | 24 | 2.2 |
| Swine | 19 | 18 | 13 | 10 | 2.0 |
| **Liquid manure** | % | lb/1,000 gal | | | |
| Beef | 3 | 16 | 7 | 15 | 1.6 |
| Dairy: liquid (< 4.0% DM) | 2 | 14 | 4 | 14 | 1.1 |
| Dairy: slurry (4.1–11.0% DM) | 6 | 24 | 8 | 21 | 2.2 |
| Goat | 4 | 17 | 8 | 19 | 1.7 |
| Poultry | 2 | 12 | 7 | 9 | 1.3 |
| Swine: finish (indoor pit) | 5 | 43 | 18 | 28 | 3.2 |
| Swine: finish (outdoor pit) | 2 | 18 | 7 | 10 | 1.0 |
| Swine: (farrow-nursery, indoor pit) | 2 | 21 | 8 | 13 | 1.0 |
| Veal calf | 1 | 9 | 3 | 16 | 0.6 |

### 1. Example calculations:

What are the first-year nutrient credits from solid dairy manure that is surface-applied without incorporation at a rate of 15 tons/a?

From Table 9.2, the total N, $P_2O_5$, and $K_2O$ content are 9, 4, and 8 lb/ton, respectively for a manure with more than 20% DM. From Table 9.1, the first-year nutrient availability is 25%, 80%, and 80% for N, $P_2O_5$, and $K_2O$, respectively.

**N credit = 9 lb/ton x 0.25 x 15 ton/a = 34 lb N/a**

**$P_2O_5$ credit = 4 lb/ton x 0.8 x 15 ton/a = 48 lb $P_2O_5$/a**

**$K_2O$ credit = 8 lb/ton x 0.8 x 15 ton/a = 96 lb $K_2O$/a**

What are the second-year nutrient credits from dairy manure that is surface-applied without incorporation at a rate of 20 tons/a?

From Table 9.2 the total N, $P_2O_5$, and $K_2O$ content are 9, 4, and 8 lb/ton, respectively for a manure with more than 20% DM. From Table 9.1 the second-year nutrient availability is 10% for N. There is no second-year credit given for $P_2O_5$, and $K_2O$.

**N credit = 9 lb/ton x 0.1 x 20 ton/a = 18 lb N/a**

### 2. Example calculation:

From the previous example, let's say that 20 tons/a of dairy manure was surface-applied without incorporation last year and 15 tons/a of dairy manure was surface-applied without incorporation this year.

What are the total amount of manure nutrient credits for this year's crop?

Total nutrient credits this season:

**N credit = 34 + 18 = 52 lb N/a**

**$P_2O_5$ credit = 48 + 0 = 48 lb $P_2O_5$/a**

**$K_2O$ credit = 96 + 0 = 96 lb $K_2O$/a**

Estimates of first-year available nutrients from typical manures in Wisconsin are provided in Table 9.3. This table should be used if manure has not been tested and book value nutrient contents will be used to determine nutrient credits. First-year nutrient credits are calculated by multiplying the estimated available nutrients (Table 9.3) by the manure application rate.

Guidelines for using manure as a nutrient source can be found in UW-Extension publication *Guidelines for Applying Manure to Pasture and Cropland in Wisconsin* (A3392). Before applying manure, be sure you understand all applicable state and federal regulatory requirements.

**Table 9.3.** Estimated first-year available nutrient content of manures.[a]

| | N | | | $P_2O_5$ | $K_2O$ | S |
|---|---|---|---|---|---|---|
| | Time to incorporation | | | | | |
| | > 72 hours or not incorporated | 1 to 72 hours | < 1 hour or injected | | | |
| **Solid manure** | lb/ton | | | | | |
| Beef | 3 | 4 | 5 | 6 | 10 | 1 |
| Dairy: semi-solid (11.1–20.0% DM[b]) | 2 | 2 | 3 | 3 | 5 | 1 |
| Dairy: solid (> 20.0% DM) | 2 | 3 | 3 | 3 | 6 | 1 |
| Goat | 3 | 4 | 5 | 6 | 8 | 1 |
| Horse | 2 | 3 | 4 | 5 | 6 | 1 |
| Poultry: chicken | 24 | 27 | 29 | 35 | 26 | 2 |
| Poultry: duck | 6 | 7 | 7 | 8 | 7 | 1 |
| Poultry: turkey | 26 | 28 | 31 | 35 | 25 | 2 |
| Sheep | 5 | 6 | 7 | 7 | 19 | 1 |
| Swine | 7 | 9 | 12 | 10 | 8 | 1 |
| **Liquid manure** | lb/1000 gal | | | | | |
| Beef | 5 | 6 | 8 | 6 | 12 | 1 |
| Dairy: liquid (< 4.0% DM) | 4 | 6 | 7 | 3 | 11 | 1 |
| Dairy: slurry (4.1–11.0% DM) | 7 | 10 | 12 | 6 | 17 | 1 |
| Goat | 4 | 5 | 6 | 6 | 15 | 1 |
| Poultry | 6 | 7 | 7 | 6 | 7 | 1 |
| Swine: finish (indoor pit) | 17 | 22 | 28 | 14 | 22 | 2 |
| Swine: finish (outdoor pit) | 7 | 9 | 12 | 6 | 8 | 1 |
| Swine: (farrow-nursery, indoor pit) | 8 | 10 | 14 | 6 | 10 | 1 |
| Veal calf | 3 | 4 | 4 | 2 | 13 | 1 |

[a] These estimates are based on the typical total nutrient contents of manures tested in Wisconsin (Table 9.2) multiplied by the estimated first-year nutrient availability (Table 9.1).

[b] DM = dry matter